Docket 11240

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

IN RE: APPLICATION OF	)	
MARTTI Y.O. KANGAS	)	APPARATUS FOR PAPER MAKING
SERIAL NO. 10/721,406	)	AND PAPER SURFACE ENHANCEMENT
FILING DATE: NOVEMBER 24, 2003	)	
EXAMINER: HALPERN	)	
ART UNIT: 1731	)	

HONORABLE COMMISSIONER FOR PATENTS

SIR:

This is in response to the final rejection mailed June 6, 2006.

By way of background, modern paper machines, up to1,000 feet long, produce continuous paper webs that are up to 30 feet wide. Operational speed is up to 6,000 feet per minute, typically around 5,000 feet per minute (83 feet per second). A machine will cost around $400 million fully installed. The industry is highly capital intensive and operates 24 hours a day, 7 days a week.

The paper industry has been coating and sizing paper for over 50 years. The industry is not going to adopt the technology as presented by Shortridge and Zapp with nozzles that move across the paper web at any speed. A failure or malfunction of one single nozzle will be missed by the integrating paper machine sensors due to the high speed. The printer/customer will reject all paper containing this defect. Flow sensors, actuators and control valves could theoretically be installed on each of the rotating nozzle lines, and the information could be transmitted wirelessly to the machine central computer, but adding the needed electronics in this high heat environment would be very complicated. And in any case, after each indicated malfunctioning, the paper machine must be shut down and the defective nozzle with accessories or its electronics must be replaced.

Additionally, paper mills are not looking for an even coating and sizing layer any more. They are looking for the ability to apply the needed but varying amount of coating color or size at exact positions across the moving paper web. This uneven addition is desired as the paper web properties changes daily across the sheet based on minute wear and plugging tendencies of a myriad of various water removal and sheet surface processing equipment. In this environment, it is irrational to apply coating or sizing utilizing across the web moving nozzles.

The paper industry is keenly aware of the huge importance of the correct cross-directional (CD) fiber and moisture profile. Uneven profiles can reduce the machine production capacity by over 20%. With today's much thinner coated magazine paper grades even a one micron thicker CD area would not allow the paper to be rolled to sufficiently large paper rolls for further processing. The web would start breaking down after only a few feet of paper accumulation on the spool.

The CD moisture profiling today is totally computer controlled and is typically done by using 4 to 5 rows of specialty nozzles that spray highly purified water. This is just one of the dozen or so different ways to make an even paper machine CD profile. It was not by accident that applicants chose to work with a global leader for re-moisturizing profile equipment.

Applicants' invention aims to provide functional spray coating and sizing applicators, capable of applying the material at exacting positions across the paper machine as needed. The paper industry has tried to do the same with existing blade coating technology but that does not work properly as the blades must be rigid to doctor the excess coating color down to the desired level. These rigid steel blades also wear very rapidly and must be replaced as soon as the wear shows up in the end product. Applicants' invention will replace the current paper coating technology.

The paper industry has tried to apply spray technology to coat and size paper and board for several decades but has failed. Understanding small droplet behavior is critical for building a functioning spray system for the difficult to spray coating colors and size. Nobel price winner Lord Rayleigh showed a century ago that small droplets are controlled totally by their size, surface tension and their electrostatic forces. This explains why these droplets keep on breaking down spontaneously until they reach their final balance, often as aerosols, photographed only a few years ago using high speed cameras.

Applicants' nozzle manufacturing associate has tried this for years together with the paper industry in sizing (the easy one) by using their existing nozzles and their profile controlled re-moisturizing spray boxes. Applicants showed applicants' associate first how their nozzle must be modified, and then how a spray box must be designed to make them work in unison. The reported and failed spray tests by professionals in the paper mills show that applicants' spray box invention is not obvious even for industry specialists.

Metso, the largest global equipment manufacturer, supplied the only commercial spray coating applicator in 2003 in Germany. Metso failed to sell a second unit. Applicants have just

delivered the first pilot unit to a major North American board manufacturer which *intends to use* it to develop new board grades.

- Metso's unit has proven that spray technology can improve the machine operating efficiency.
- The wear of high pressure nozzles is a major impediment as was predicted.
- Metso claims in their US patent 6,063,449, referring to applicants' U.S. method patent 4,944,960 (counterpart valid also in Germany) that applicants' patent covers only "gas–liquid nozzle or ultrasonic nozzle" omitting conveniently the high pressure nozzle that is referred as "...fluid type nozzle wherein the nozzle will break up the fluid that flows therethrough...", and continues further by claiming that applicants' system would create dusting and dirt problems at the printing shop. On the contrary today, it appears that Metso's system has problems and applicants' works. Relative to financial resources this is like a struggle between David and Goliath. Applicants' invention shows how a high surface smoothness for paper web can be created (Figures 4-7). Applicants have proven this with a major US paper manufacturer. Its laboratory found no differences in paper surface properties between applicants' and their own coated paper.
- Applicants favored the low pressure nozzles as they are the only ones that allow the practical CD profile control.
- High pressure or hydraulic nozzles operate around 100 atmosphere pressure is unsuitable for a working environment.
- Despite over three years of trying, Metso has not been able to modify the unit in Germany to make the produced paper acceptable for any high quality printing. The poor printability is due to the physics of the high pressure spraying. The tiny plate or needle shaped particles are shot at high speed towards the paper surface, like projectiles, and will get stuck at whatever angle they penetrate.

With respect to Shortridge, cited by the examiner, the spray nozzles are pulled by a continuous cable on roller carts across the web in two parallel paths with semicircles providing for the turning areas:

- The paper machine online quality sensors measure everything from paper quality that is technically feasible. The results are integrated over a few minutes per paper machine CD position. These readings control the production and the CD profile on a continuous basis.

- The mill must know how each nozzle is operating at all times. Applicants' nozzle assembly includes a highly sensitive nozzle performance alarm system (Figure 8).
- To accommodate a modern paper machine, the Shortridge centrally fed coating system would become complex. Two such units per paper side would be needed. Each unit would contain 200 rotating nozzles with attached flexible feed lines, sensors, actuators, and control valves. Also an enclosure is needed to prevent the nozzle ejector effect from "vacuuming" droplets from the spraying area through the nozzle slit. Additional cooling would be required to decrease the electronic components failure rate in this hot and moist environment.
- Let's assume that somebody would add the continuously traversing profile controlling spray system (Shortridge or Zapp) on their paper machine. Sooner or later one nozzle line will plug or its dispersion power will disappear. The now faulty spraying will be distributed evenly across the web. During plugging the paper machine sensors would see only a tiny reduction in coating color amount over the whole web. This would not cause an alarm due to integration and the extreme speed this spot passes the sensor resulting that the main flow controller to correct. A new sensor is needed to detect this type of flaw. In a case of lost dispersion power, the paper machine sensors would see nothing. But in both cases the whole production will become an instant reject for print shops. The issue is when the problem will be discovered. In the best case the operator would notice it during the next "jumbo roll" change. The instant action would be to shut the paper machine down and fix the problem. Minimum damage would be one wasted "jumbo roll" and with added shut down the minimum loss would be 5% of the daily production.
- According to applicants' invention, the mill would instantly receive the alarm that one nozzle is not working and that nozzle would automatically shut down. Normally the neighboring nozzles would compensate for this loss. In the worst case, the loss is one client roll on the winder where the "jumbo roll" is further cut to several client rolls.

Shortridge uses a slit (slit, Fig 1 item 5) to lead a leather object into the spray area and has provided a similar slit on the opposite side for leading the object out. Shortridge assumes that the spray particles that leave the nozzle will stick mostly to the object surface. These "large" spray droplets are not acceptable in paper coating as they tend to produce mottled surface that may become visible only after printing. The fine droplets or mist cover the paper surface as desired but the laws of physics tell that charged and sticky aerosols will be generated. Shortridge

does not provide any solution for the aerosol problem, nor does he appear to recognize it's seriousness. He uses the words squirting or spraying and this indicating of a coarse spray. That is just perfect when the paint layer is relatively thick as the surface tension will even out the layer thickness variations. If the spray solids are simultaneously low, aerosols are not forming in large quantities. Also note that leather and paper are totally different substrates, paper is very porous and hygroscopic.

Contrary to painting leather, wood or metal, in the paper industry, thin layers of coating color must be used to cover the paper surface. The sprayed coating color will contain enough unabsorbed liquids that can aid the smoothening process only for about $1/10^{th}$ of a second. Applicants' smoothening devices (Figures 4-7) are built to utilize this time slot within the first 20 milliseconds.

Shortridge does not show anything that would be related to applicants' smoothening devices and he apparently assumes that the paint layer will even out to a smooth surface aided by the surface tension of the sprayed paint.

One has to note that the paper coating colors are not the same as the paints even if same mineral components are often used and some latex components might be the same. The paper industry makes their own coating colors to suit, adding other chemical components for their specific goals. The paper coating color minerals are refined carefully to their maximum optical reflectivity targeting 0.5 microns in size and with this they are well suited to the thinnest possible coating jobs, unparalleled in any of the major paint using industries where the paint is used to protect the much more expensive products. The paper industry aims to make the least expensive highest quality printing surface for magazines and advertising.

According to applicants' invention, preventing air from entering the spray box spray area is critical for proper functioning of the box (Figures 1-4):

- Fig 1. shows a gap that can be used with a dynamic back pressure balanced box
- Fig 2. shows a sudden change in web direction shooting the air at 45 degree angle upwards to the right and sucking the air from the below box area upwards
- Fig 3. has a solid roller 13 cutting the incoming air flow
- Fig 4. shows a gas (like steam) blade that can be used e.g. in Fig. 1. at the outlet side and on the edges to keep the pressure inside the spraying area in balance. However, the edges can be balanced also by using the end row nozzles for that purpose (without spray liquid)

If the air would enter the box this would create unfavorable aerosol formation *inside the* spray area. If this continues the charged aerosol particles would multiply rapidly, become sticky and fixate to any solid surface inside the spray box or perhaps onto the nozzles.

Also, the aerosols must not escape the spray box into the operating room environment where people and electronics become vulnerable. Applicants secure this by controlling the gas/air removal from the box in an orderly way as shown (Figure 11).

With respect to Zapp, cited by the examiner, the equipment would require at least 60 feet long open space above the paper web for one sided coating and another 60 feet to coat the other side. A modern paper machine design does not allow for this without significant added cost.

As with Shortridge, CD coating color spray profile control would be practically impossible to implement. The rotating ring forces more coating color to the sides than the center. Rotation of the rings would cause unnecessary cross-overs and a moiré pattern that could not be fixed. No smoothening device or doctor would work with Zapp rings leaving all high quality paper grades out of question. Also, the apparatus must be fully enclosed but how to do this is not shown in Zapp.

In summary, it is believed that claims 10-19 are allowable over Shortridge or Zapp due to the following:

1. Paper is a porous and hygroscopic substrate that will readily absorb liquids, starches and coating colors. Meanwhile leather, wood, metal surfaces and the like will absorb paints and liquids very little or not at all.
2. In paper making, the coating color solids must be high to reduce the cost of drying. The paper surface must become totally dry from coating color application before the paper is rolled to large "jumbo rolls" that can exceed 3 m (10 feet) in diameter. With thin papers, this means drying the coating color within 10 to 15 seconds, and with heaviest boards from 20 seconds up to almost 2 minutes depending on the application amount and point.
3. Paper machine speeds can exceed conventional spray painting process by several orders of magnitude.
4. CD profile control is a must in the paper industry. The across the sheet spraying of both Shortridge and Zapp have a high probability of creating stripes and other undesirable patterns across the whole width of the web which will render the whole production instantly unprintable and the machine must be shut down to fix the problem. In comparison, applicants' invention allows the production to continue until the next

planned machine shut down. In the best case nothing is lost due to compensation, and in the worst case the loss is one client roll on the winder as the "jumbo roll" is further sliced per client requirements.

5. In conventional spray painting, the relatively inexpensive paint is used adequately to protect the more expensive products like metal, wood and leather. Whereas in paper coating the inexpensive fibrous substrate is covered by relatively expensive coating color. The coating color quantity has to be minimized yet yielding a competitive quality printing surface for the magazines and advertisers. The ever increasing freight cost has forced the paper makers to make thinner paper that demands even more precise CD paper web profile control.

In response to the rejection of the claims based on the judicially created doctrine of obvious-type double patented, enclosed herewith is a terminal disclaimer to obviate the rejection.

From the above, it is believed that this application is in condition for allowance. Therefore, reconsideration and allowance of claims 10-19 are requested.

Respectfully submitted,

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